HP Special Focus | Maintenance and Reliability

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# Alternatives to ladders and platforms for inspection and maintenance of elevated flare tips

Flare systems are used in refineries and chemical plants as a last line of defense for the plant by burning all unwanted gases and liquid during any upset or emergency condition. As flare systems are key safety equipment for processing plants, they must be adequately maintained through periodic inspection, with minimum time out of operation.

The traditional design of elevated flares uses ladders and platforms throughout the stack to access the flare tip for inspection and maintenance. Many plant owners still utilize this traditional design. However, considering other means for inspection and maintenance of flare tips during basic engineering could reduce the extent of intermediate ladders and platforms required to access flare tips.

This article describes various methods to access elevated flare tips for inspection and maintenance. These methods also provide benefits, such as enhanced safety for inspection and maintenance teams and reduced maintenance time. Two case studies illustrate potential cost savings based on in-house estimates from the optimization of intermediate ladders and platforms.

**Introduction to elevated flares.** An elevated flare is the most commonly utilized flare system in a refinery or a chemical plant where the waste gas stream is fed to a tall stack and is combusted at the tip of the stack. The flare burns all waste hydrocarbons in a safe, reliable and efficient manner before discharge into the environment.

The flare must remain in operation at all times to mitigate any upset condition or emergency situation at the plant. This can result in substantial deterioration of the flare tip due to continuous operation at high temperature. As a result, the flare tip requires inspection and maintenance at regular intervals in the shortest possible time span to keep it permanently available for the safety of the plant.

Elevated flares are further categorized by the type of stack supports[1]: i.e., self-supported, guy-wire-supported or derrick-supported (**FIG. 1**).

An elevated flare tip must be inspected during planned shutdowns every 3 yr–5 yr. Flare tips do not usually require much maintenance, as the flare tip is a simple pipe or shell that is open to atmosphere. Flare tip maintenance includes replacement with a new tip after several years of material corrosion and deterioration due to very high temperature. Auxiliary components such as the pilot, the thermocouple and the aircraft warning lights, which are located near the flare tip, require frequent inspection and maintenance.

The majority of the elevated flare system uses conventional ladders and platforms to access the flare tip for inspection and maintenance work. A full platform is provided near the tip, along with intermediate platforms and ladders from the grade to the flare tip. This conventional method not only adds substantial cost as the stack structure becomes more rigid, but it also poses safety threats (fall hazard) for maintenance personnel working at high elevation.

Another safety hazard is ice on the platforms in winter. In cold weather, ice can form on the access platforms at the top of the flare due to strong winds, freezing rain/snow and motive steam. Unsafe conditions are created due to the risk of falling ice blocks and excessive loads on the stack at elevation.

Another important aspect is the limited time available for inspection and overhaul of flare tips. The flare system is the last equipment to be taken out of operation during regular shutdown for maintenance and the first equipment to be started when plant operation resumes; therefore, only a small window is available to carry out inspection and maintenance of flare tips during regular plant shutdown. Accessing flare tips by ladders and platforms increases overhaul time, thereby increasing plant shutdown time and resulting in production losses.

**Alternatives to ladders/platforms for flare tip access.** A flare tip grants access for inspection and maintenance of auxiliary components—i.e. pilots, thermocouples and aircraft warn-

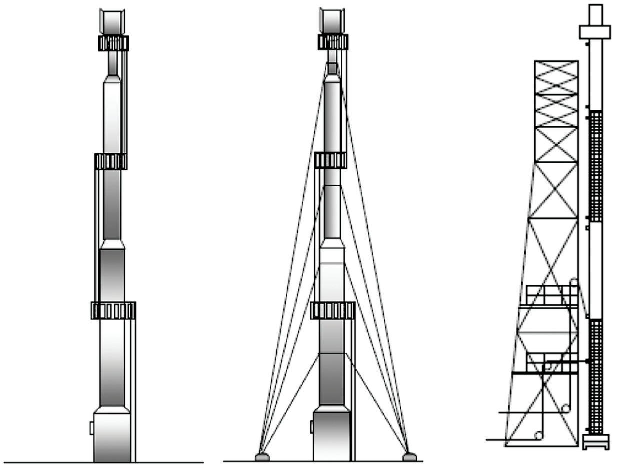
(a) Self-supported (b) Guy-wire-supported (c) Derrick-supported

**FIG. 1.** Stack support types for elevated flares.

ing lights. These items should be retractable, making them accessible from the grade for inspection and maintenance. Other alternatives for access include crane, rope, helicopter, retractable (demountable) flare tip and drone cameras.[2]

Drone cameras can provide a safe, reliable and economical method of inspection for the flare tip while in operation (**FIG. 2**). An un-crewed aircraft installed with a high-definition camera is used for visual inspection of the tip. The camera is equipped with a high-zoom feature that enables a clear picture to be taken from a safe distance at any angle. In this way, a team consisting of the drone operator and the flare inspector can gain a clear view of the operating flare from the ground (**FIG. 3**).

This remote inspection helps maintenance teams in advance planning for the scope of remedial work on the flare system during planned shutdown. In lieu of a remote check, the maintenance team must physically access the tip during shutdown, when the flare is out of operation, which causes delays in the maintenance schedule.

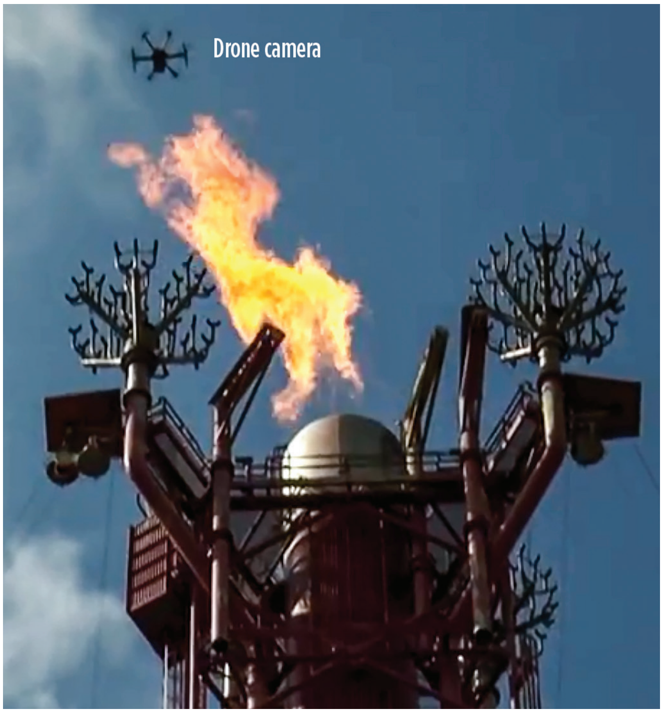

**FIG. 2.** Drone cameras provide a safe and economical method of inspection for flare tips while in operation.

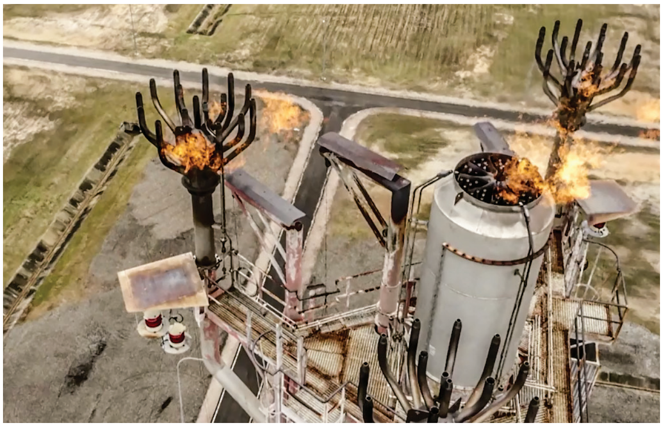

**FIG. 3.** A drone camera's high-zoom feature enables a clear picture to be taken of a flare tip from a safe distance.

These access alternatives can be discussed with the client at an early stage of flare design (front-end engineering design or basic engineering) to finalize the extent of ladders and platforms for tip access, instead of providing ladders and platforms along the full height of stack.

**Case studies for flare access.** Two cases follow in which studies were carried out for the optimization of ladders and platforms on a stack during basic engineering of an elevated flare system. These studies resulted in a significant reduction of intermediate ladders and platforms. The ladders and platforms along the full stack height could have been avoided in these scenarios by considering other methods to access the flare tip for inspection.

**Case 1: Guy-wire-supported stack.** A self-supported or guy-wire-supported flare stack is usually provided with ladders and platforms to access the flare tip for inspection and maintenance. A study was done on a 50-m-tall flare stack to reduce the shutdown time for inspection and maintenance work on the flare tip.

Drone camera, helicopter, rope access and crane were the feasible options by which the flare tip could be accessed in the shortest time. The use of a drone camera for inspection and a crane to access the tip were shortlisted as being economical and safe options, due to the relatively low height of the flare stack. A 360° platform, to be accessed by crane, would be required at the flare tip for the demounting operation.

Pilots, thermocouples and aircraft warning lights were accessible from the grade for inspection and maintenance; there-

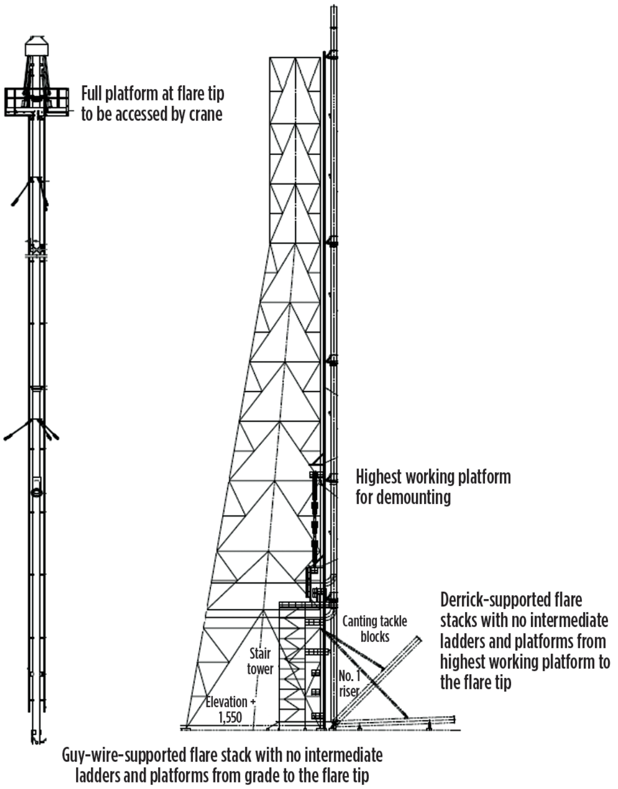
Full platform at flare tip to be accessed by crane
Highest working platform for demounting
Derrick-supported flare stacks with no intermediate ladders and platforms from highest working platform to the flare tip
Canting tackle blocks
Stair tower
No. 1 riser
Elevation + 1,550
Guy-wire-supported flare stack with no intermediate ladders and platforms from grade to the flare tip

**FIG. 4.** The elimination of some ladders and platforms from the flare tip inspection resulted in substantial cost savings.

fore, intermediate ladders and platforms from grade to the flare tip would not be required (**FIG. 4**). An in-house estimate resulted in potential cost savings of approximately $75,000 by removing the intermediate ladders and platforms from grade to the top platform at the flare tip.

**Case 2: Derrick-supported stack.** Another scenario considered tall flare stacks that are derrick-supported. Derricks can support a single or multiple flare stacks. The need for multiple flare stacks installed in a single derrick can be due to several factors:

- The flare system must be 100% available for continuous operation and, therefore, must be provided with equal spare flare stacks—i.e., one working and one on standby
- Multiple flare systems are installed in a common derrick
- A combination of the above factors—i.e., multiple flare systems with a common spare.

A derrick with multiple stacks should be demountable to allow maintenance by retracting the flare tip to grade without interrupting the operation of adjacent stacks. A common winch skid for demounting the tip should be considered in basic design. In such a scenario, ladders and platforms are not needed for the full height of the flare stack. Instead, these flare systems can be provided with the highest working platform per the requirements of the demounting operation.

Several aspects should be considered during basic engineering of derrick supports for multiple flare stacks for the removal of intermediate ladders and platforms between the highest working platform and the flare tip. These aspects include:

- The flare stack, flare tip and other components (thermocouple, pilot, aircraft warning lights, etc.) must be retractable as per the basic design.
- Multiple flare systems may be installed in a common derrick; therefore, it is unlikely that all of the flare systems will be simultaneously shut down to carry out inspection and maintenance of flare tips.
- A spare stack may be considered to ensure the permanent availability of the flare system. In the examined case, the flare tip requiring maintenance was determined to be inaccessible during operation, as it posed a safety hazard to maintenance personnel due to the high thermal radiation of the neighboring stack.
- The use of a drone camera to inspect the flare tip without interrupting flare operation should be considered.
- The derrick design should consider a demounting system for retracting the flare tip to grade for maintenance work. A winch skid for mounting/demounting operation should be provided.

A study of these key points on a 150-m-tall, derrick-supported, multiple-flare system shows that the derrick would require ladders and platforms up to 50 m in height for facilitating the demounting of the flare stack and tip. This requirement could avoid the need for intermediate ladders and platforms for a height of 100 m. An in-house estimate for this design shows potential saving of approximately $300,000 per derrick.

If a derrick has a single stack, then inspection by a drone camera is the economical option without interrupting the flare operation. The thermocouple, pilot, aircraft warning lights, etc. should be retractable, as per basic design. Demounting the flare tip for maintenance can be achieved with several methods:

- A crane or helicopter, depending on the flare tip elevation from grade. A 360° platform will be required at the flare tip for both cases.
- A demounting system—i.e., winch skid.

The selection of any of the methods detailed in the aforementioned case studies depends on an economic analysis and should be discussed with the client at an early stage of engineering.

## Recommendations.

A flare designer should consider all available methods to access the flare tip for inspection and maintenance and should discuss these methods with the client at an early stage of engineering, preferably during front-end engineering design. These considerations and discussions will help optimize the extent of ladders and platforms needed to access flare tips, thereby ensuring the safety of maintenance personnel, decreasing total overhaul time and reducing maintenance costs. HP

### LITERATURE CITED

[1] American Petroleum Institute, "API Standard 537: Flare details for general refinery and petrochemical service," 3rd Ed., March 2017.

[2] Droneworks Asia, "UAV utilization for live flare tip, structure and pipe line inspections," February 6, 2017, YouTube, online: https://www.youtube.com/watch?v=e5X-DjNhd0Aandt=47s

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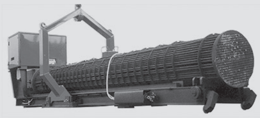
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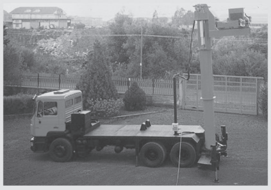
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